1. **PFOA derivatives used for AFFF fire fighting foams were never intended for use as primary fire extinguishants:** The first such product designed for combating fire was developed in the early 1960s by Chemical Concentrates, which had been working with new surfactant materials developed by the 3M Company. A surfactant is a “surface active agent”, and its primary usefulness is to reduce the surface tension of other liquids, for the most part water. The objective of the Chemical Concentrates work was to find fire-fighting foam that would improve upon the fire extinguishing performance of protein based foam liquids that complied with JAN Spec OF555C. Chemical Concentrates concluded that the product was not yet perfected since the film it formed would not reliably survive fuel or substrate temperatures in excess of 90 ^{0} F [Fourth Quintennial Symposium on Fire Fighting Foams”, August 1964, prepared by Mearle Corporation, Presentation by Arthur Ratzer]. Nevertheless it did prove to be of interest to Navy Research Laboratories. In 1964, NRL published its work on “Light Water”, known now as AFFF, in which they concluded that the product could serve as a “vapor securing agent” [“A New Vapor Securing Agent for Flammable Liquid Fire Extinguishment”, US Naval Research Laboratory (NRL), March 1964]. The recommendation of NRL was to use the product as an element in a “dual agent” system. The use was to apply the foam produced from the surfactant as a "vapor securing agent", not as an extinguishant. The product in question was the same essential product as is in use today, a “long chain” fluorinated hydrocarbon surfactant, expressed chemically as C_8F_{17}. Since NRL was not able to overcome the low ignition temperature deficiency discovered earlier at Chemical Concentrates, and did not originally intend for the new product to be used as a “primary agent”, it was accepted that a new specification would be developed (MIL F 24385 F). The specification is still in use. The transformation of “Light Water” or AFFF from a “vapor securing agent” to a fire fighting foam “primary agent” is explained in part in court records from 3M’s unsuccessful suit against Ansul and Ciba Geigy Companies in 1981 [US District Court, Eastern District of Wisconsin; Minnesota Mining and Manufacturing, Plaintiff, *v.* The Ansul Company & Ciba-Geigy Corporation, Defendants. Docket 78-C-330. The Court invalidated 3M patents for perfluorinated hydrocarbon surfactant based fire fighting products].

2. **PFOA and PFOS derivatives called AFFF fire fighting foams can be dangerous:**
The low ignition temperature of the surfactant used to produce AFFF material has caused severe cases of "burn back" which takes place if the fluorocarbon forming a film on a fuel ignites due to proximity to hot metal or other heat greater that its ignition temperature. Destruction of the vapor securing fluorocarbon film and the possible fuel re-ignition can be as rapid as the original elapsed time of involvement of a hydrocarbon spill fire. FAA films taken in 1989 show this vividly. In addition, chemical models have suggested that fluorine, the most reactive of the elements, will attack and remove the oxide coating of boron used in composite aircraft fuselage components and other applications, thus shortening the time required for ignition and increasing the rate of boron combustion. Recent shock-tube experiments at the University of Illinois have shown that propellants containing fluorine can significantly enhance the combustion of energetic boron particles. Boron has a low molecular weight and a high energy of combustion, making it an attractive additive for use in rocket propellants. This reaction may explain repeated instances of difficulty in controlling fires associated with aircraft containing significant amounts of carbon-boron composites.

3. **PFOA and PFOS derivatives called AFFF fire fighting foams have always been replaceable with equal or better products**
Empirical evidence available from Air Force Research Laboratories and Air Force Aeronautical Systems Center among others confirms that the efficacy of AFFF is generally similar in practical application to that of loaded stream charge systems. This technology pre-dates the Second World War. Loaded stream systems rely on a concentrated solution or mixture of one of various potassium salts and water. This solution or mixture produces a non-combustible fuel-in-water emulsion when properly applied. Such systems compare well to the performance of AFFF systems, especially those used in the military services that are non-aspirated (extinguished fire surface area per pound of agent on board ~ 4ft2 / lb.). By comparison, foam systems capable of delivering fire extinguishing efficacies ranging from ~ 11 to 15 f2 / lb. could be deployed, so the abandonment of many foam generation and delivery systems that rely on fluorocarbon based foams could be of extreme benefit to the fire service.

The ability of a film forming foam to spread over fuel results from lowered liquid surface and interfacial tensions. The very large decrease in surface tension obtained by aspirated AFFF compared to that of the older aspirated protein or less effective hydrocarbon surfactant based foams has not resulted in any meaningful increased efficiency in extinguishing fire. Fluorocarbon based materials, despite very wide use, have not brought about any reduction in foam solution application rates in National Fire Protection Association standards regarding the design of fire-fighting foam systems. This is an indication that supposedly unique attributes of AFFF type agents (film forming ability and spreading capacity) are in fact irrelevant and cannot properly be used to predict fire-fighting performance.

Dry chemical powders made from potassium bicarbonate, potassium chloride, sodium bicarbonate and monoamonium phosphate have well established abilities for extinguishing fire and have been readily available since the end of the Second World War. Potassium bicarbonate and sodium bicarbonate are especially suitable for controlling the same types of fires for which foam systems are most widely deployed. They vastly exceed the practical efficacy of fluorocarbon based foams (extinguished fire surface area per pound of agent on board ~ 11 to 15 ft2 / lb.). These compounds are ubiquitous in nature; considered to be "generally recognized as safe" (GRAS) by the Food and Drug Administration; naturally present in human food; widely distributed in commerce; available to the general public, and required for normal function in human, animal, plant and environmental systems. Potassium bicarbonate and sodium bicarbonate are not associated with adverse effects to humans. The conventional thinking that dry chemical powders cannot be successfully used to control flammable liquid fires, the primary application of AFFF foams, is contradicted by the routine results of UL testing of common portable and mobile dry chemical fire extinguishing systems. It is important to note that UL test procedures do not allow for any burn back or fuel re-ignition.